ANATOMICAL RISK FACTORS

dratef.net

- Pes Planus
- Pes Planus Deformity — Bunionette
- Pes Cavus
- Bunionette (Tailor's Bunion)
- Claw Toes
- Claw and Curly Toe Deformities
- Varus Deformity of Toes
- Heloma Durum, Bunion, Bursitis, Claw Toe
- Heloma Molle
- Hallux Valgus with Overriding Toe
- Convex Triangular Foot (Hallux Valgus and Quintus Vargus)
- Hallux Valgus, Overriding Toe, Claw Toes, Edema
- Onychomycosis: Hallux Valgus and Hammer Toe Deformity
- Mallet Toe
- Prominent Metatarsal Heads and Claw Toes

- Postoperative Hallux Valgus After Second Toe Removal
- First Ray Amputation
- Callus Under Bone Prominence
- Callus over Prominent Metatarsal Heads
- Hemorrhagic Callus
- Ulcer Under a Callus Area
- Ulcer Under Hallux
- Heel Cracks
- Bilateral Chopart Disarticulation
- Neuropathic Ulcer
- Ingrown Nails (Onychocryptosis)

PES PLANUS (FLAT FOOT)

A 73-year-old female patient with type 2 diabetes diagnosed at the age of 55 years and treated with insulin since the age of 65 years, attended the diabetic foot clinic because of a small superficial painful ulcer over her medial malleolus. The patient complained of dysesthesias (she had a cold or warm sensation in her feet), and she had hypertension for which she had been treated with enalapril since the age of 55 years. The ulcer was noticed 4 weeks previously and had been caused by an external minor trauma.

On examination, bilateral pes planus with minor hyperkeratosis over the first metatarsal head was found (Figure 3.1). The ankle brachial index, peripheral pulses, vibration perception threshold, and monofilament (5.07) sensation were all normal. The ulcer was debrided on a weekly basis, and it healed in 4 weeks.

Pes planus (or flat foot) is characterized by diminished longitudinal and transverse concavities of the foot. Diminished plantar transverse concavity is associated with an increase in frontal transverse convexity of the tarsometatarsal joint line (Lisfranc joint line) and divergence of the five metatarsal bones. The load transfer is displaced to the medial border of the midtarsal region. However, there is evidence that flat feet protect against loading of the metatarsal heads, although they are poor shock absorbers. Pes planus may cause bunionette formation and plantar heel spur pain, but other foot problems are uncommon. Foot orthotics and arch supports do not alter the osseous relationships and are ineffective in many patients. Surgical treatment is rarely indicated in adults.

Keywords: Pes planus; malleoli ulcer; infection

PES PLANUS DEFORMITY — BUNIONETTE

A 74-year-old male patient with type 2 diabetes diagnosed at the age of 61 years attended the outpatient diabetic foot clinic for chiropody treatment. On examination, he was found to have mild callus formation

Figure 3.1 Pes planus

at the plantar and the lateral area of the fifth metatarsal head (Figures 3.2 and 3.3). Bilateral pes planus (flat foot) deformity of his feet and a bony prominence at the lateral aspect of the fifth metatarsal head (a bunionette or tailor's bunion) were also found (see Figure 3.2). Blackening of the nail of the hallux was due to a subungual hematoma. Pedal pulses were palpable and the patient had severe peripheral neuropathy. The patient had the callus removed and was instructed in appropriate foot care. In addition, he was advised to wear suitable shoes with a wide toe box.

Pes planus or flat foot is the commonest foot deformity (prevalence is about 20% in the adult population) and its prevalence increases with the age. The majority of flat feet are considered to be variations of normal. People with this deformity are able to walk as comfortably as people with normal arches (see also Figure 3.1).

Keywords: Pes planus; flat foot; bunionette

PES CAVUS

A 64-year-old female patient with type 2 diabetes diagnosed at the age of 62 years was referred to the outpatient diabetic foot

Figure 3.2 Pes planus with bunionette. Plantar aspect

Figure 3.3 Pes planus with bunionette. Dorsal aspect

Figure 3.4 Pes cavus

clinic for foot care. She had been treated with insulin for the last 4 years. The patient had a history of hypertension. No diabetic complications were mentioned.

On examination, peripheral pulses were bounding. She had severe peripheral neuropathy (no sensation of pain, light touch, temperature, vibration or 5.07 monofilaments) and dry skin. A high plantar arch due to pes cavus was noted, which was more apparent in the standing position. Mild hallux valgus, clawing of the toes, and callus formation over the inner aspect of the first metatarsal heads as well as at the tip of the second toe and the second metatarsal head bilaterally were observed (Figure 3.4). The patient had the callus removed, and the nails cut and she was educated in foot care. Suitable shoes and insoles were prescribed and she was advised to attend the foot clinic on a monthly basis for chiropody treatment.

Pes cavus is a deformity not necessarily related to diabetes. Indeed, the patient mentioned that her foot shape had been the same before the diagnosis of diabetes and her mother probably had the same deformity.

Normally the inner edge of the midfoot is raised off the floor forming an arch, which extends between the first metatarsal and the calcaneus. When the arch of the foot is higher than normal (pes cavus) claw toes often develop. In cavus foot the forefoot, and especially the first ray, is drawn downwards and an abnormal distribution of plantar pressure upon standing and walking leads to callus formation under the metatarsal heads. Cavus feet tend to be stiffer than normal; some patients may be prone to ankle strains. Patients should be advised to wear appropriate shoes (extra depth and broad at the toe box) and

Figure 3.5 Bunionette with claw toes

orthotic, shock-absorbing insoles. Surgery for the correction of the abnormality is rarely recommended.

Keywords: Pes cavus

BUNIONETTE (TAILOR'S BUNION)

A 54-year-old female diabetic patient attended the outpatient diabetic foot clinic for regular chiropody treatment. She had severe diabetic neuropathy with reduced sensation of light touch, vibration, pain, temperature and 5.07 monofilaments. Peripheral pulses were normal. Muscle atrophy of the feet, claw toes, mild hallux valgus, varus deformity of the lesser toes, and an exostosis of the lateral part of the fifth metatarsal head (bunionette, Figure 3.5) were present. Another exostosis was noted at the tuberosity of the fifth metatarsal bone. Appropriate shoes with a high and broad toe box were prescribed, and the patient was educated in correct foot care.

Bunionette, or tailor's bunion, is often associated with varus deformity of the lesser toes. Ulceration over a bunionette may occur in a patient who has no feeling of pain, and an infection of the ulcer may spread to the bursa and the underlying bone.

Keywords: Bunionette

CLAW TOES

A 56-year-old male patient with type 2 diabetes diagnosed at the age of 44 years attended the outpatient diabetes clinic. He had been treated with insulin since the age of 53 years, with excellent results (HBA_{1c}: 6.7%). He had background diabetic retinopathy.

Figure 3.6 Muscle atrophy with claw toes and hallux valgus

On examination, the patient had severe diabetic neuropathy with complete loss of sensation of pain, light touch and temperature; his vibration perception threshold was 40 V on both feet; Achilles tendon reflexes were absent. Peripheral pulses were normal and the ankle brachial index was 1.2 bilaterally. Temperature of the feet was normal; the skin was dry, with normal hair and nails, while mild vein distension was noted. Severe atrophy of the intrinsic foot muscles (lumbrical and interossei) — due to motor neuropathy — resulted in an imbalance of the foot muscles, and cocked-up toes (claw toes) (Figure 3.6). Such an appearance is so typical, that the diagnosis of peripheral neuropathy can be made by inspection of the feet alone.

A claw toe, the most common deformity in diabetic patients, consists of dorsiflexion of the metatarsophalangeal joint, while the proximal interphalangeal and distal interphalangeal joints are in plantar flexion (Figure 3.7). Shifting of the fat pads underneath the metatarsal heads to the front leaves the metatarsal heads exposed; high plantar pressures develop under metatarsal heads. This patient did not have problems with his feet. He was educated in appropriate foot care and instructed to wear suitable footwear with a toe box large enough to accommodate the deformity.

Figure 3.7 Claw toe

Keywords: Muscle atrophy; peripheral neuropathy; claw toes

CLAW AND CURLY TOE DEFORMITIES

A 68-year-old female patient with type 2 diabetes attended the outpatient diabetes clinic for her usual follow-up. On examination, she had severe diabetic neuropathy and palpable peripheral pulses. Claw toe deformity of her left second and third toes was noticed, as well as a curly fourth toe (Figure 3.8). Subungual hemorrhage and ingrown hallux nail, and hemorrhagic calluses of the second and third toes were also present. A hammer deformity was seen on the second toe of her right foot. Protective

Figure 3.8 Curly fourth toe with inward malrotation. Claw toes

footwear was prescribed and the patient was educated in foot care.

A curly toe consists of neutral position or plantar flexion of the metatarsophalangeal joint, and plantar flexion of the proximal interphalangeal and distal interphalangeal joints, by more than 5° each (Figures 3.9 and 3.10). Inward or outward rotation may be present. Curly toes may be either fixed or flexible.

Keywords: Claw toe; curly toe; hammer toe

VARUS DEFORMITY OF TOES

In varus deformity of toes the third, fourth and fifth toes drift medially. The nails of the toes may cause superficial ulcers on the adjacent toes. This patient was a 60-year-old female with type 2 diabetes diagnosed at the age of 51 years. She had severe diabetic neuropathy; peripheral pulses were normal, and she had never had a foot ulcer. In addition to varus deformity, clawing of her toes was present (Figure 3.11). Varus deformity often co-exists with bunionette.

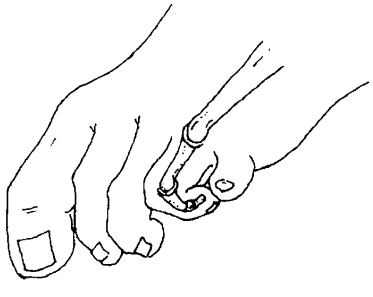

Figure 3.9 Curly fourth toe

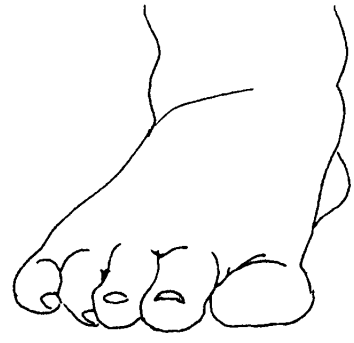

Figure 3.10 Curly fourth toe. Note inward malrotation

Keywords: Varus deformity of toes

HELOMA DURUM, BUNION, BURSITIS, CLAW TOE

A 67-year-old male patient with type 2 diabetes attended the outpatient diabetic foot

Figure 3.11 Varus and claw toes deformity

clinic because he had developed painless hyperkeratosis on the dorsum of his toes.

He had severe peripheral sensorimotor neuropathy; peripheral pulses were normal. Significant muscle atrophy was seen on the dorsum of his feet (Figure 3.12). Mild hallux valgus and claw toes deformity were also present. As a result of a bunion (see below) due to hallux valgus deformity, a red and swollen bursa developed at the medial aspect of both first metatarsal heads, caused by pressure and friction exerted on these areas by his shoes. Painless corns were also present on the dorsum of the toes. Such corns — called heloma durum or hard corns — are a result of pressure and friction on the deformed toes caused by wearing low toe box shoes. Suitable shoes (with a broad and high toe box) were prescribed in order to accommodate the deformity. The patient did well; heloma durum and bursitis did not relapse.

A bunion is a bony prominence that develops on the inner side of the foot, near the base of the first toe. An infected ulcer

Figure 3.12 Heloma durum, bunion, bursitis and claw toe

over a bunion or a heloma durum may lead to infection spreading into a joint or the bone.

Keywords: Heloma durum; bunion; bursitis; claw toe

HELOMA MOLLE

A 54-year-old male patient with type 2 diabetes diagnosed at the age of 48 years attended the outpatient diabetic foot clinic for callus removal. He had severe diabetic neuropathy (loss of sensation of pain, light touch, temperature, vibration and 5.07 monofilaments), and he complained of mild pain on his left little toe.

On examination, a painful corn was seen at the medial aspect of his left little toe (Figure 3.13).

Corns are circular hyperkeratotic areas which may be soft or hard. They have a polished or translucent center and may become painful due to persistent pressure and friction. Soft corns develop in the interdigital

Figure 3.13 Heloma molle

spaces; these are known as heloma molle, and they are caused by pressure and friction from the adjacent toe bones. This type of corn often has a soft consistency (in contrast to a heloma durum) due to moisture retention in the interdigital space. The commonest location of a heloma molle is the lateral side of the fourth toe, caused by pressure and friction on the adjacent head of the proximal phalanx of the fifth toe, but it may also occur in the other interdigital spaces. Osteoarthritic changes of the distal interphalangeal joints often cause heloma molle. Kissing heloma molles result when the ends of the phalanges are too wide. Tight shoes aggravate the problem. This condition is especially common in women who wear high-heel shoes, which shift the body's weight to the front of the foot, squeezing the toes into a narrow, tapering toe box.

Heloma molle, like heloma durum may cause discomfort, and it may be complicated by infection. The patient is advised to wear wide shoes or shoes with a high toe box. Surgical removal of small portions of the bones or the exostoses that are involved in the pathogenesis of the heloma molle is the permanent treatment.

Keywords: Corns; heloma molle; heloma durum

HALLUX VALGUS WITH OVERRIDING TOE

A 69-year-old female patient with type 2 diabetes diagnosed at the age of 55 years and treated with antidiabetic tablets was referred to the outpatient diabetic foot clinic because of a recurrent ulcer over her first left metatarsal head. The patient had no macroangiopathic complications; peripheral neuropathy was found on examination.

Hallux valgus with fixed varus deformity and clawing of second toe in supraductus was noticed, together with callus formation

Figure 3.14 Hallux valgus with overriding toe

under her first metatarsal head and ulceration of its medial aspect (Figure 3.14).

Hallux valgus and the associated varus posture of the first metatarsal bone cause various deformities of the other toes, such as varus, clawing and valgus formation. The long and short extensor tendons of all the toes shrink like bowstrings, causing subluxation of the phalangeal bases. Contractures of tendons and joint capsules result in fixation of the deformity. Due to the deformity of the third and fourth toes the heads of the three central metatarsal bones become lowered, resulting in their exposure and callus formation. In more severe cases of hallux valgus, the line of load is displaced progressively towards the medial side of the foot, and the longitudinal arch becomes lower, leading to pes planovalgus.

Keywords: Overriding toe; hallux valgus

CONVEX TRIANGULAR FOOT (HALLUX VALGUS AND QUINTUS VARUS)

A 48-year-old female diabetic patient with type 2 diabetes diagnosed 6 months before her first visit, and treated with sulfonylurea, was referred to the outpatient diabetic foot clinic because of an ulcer on her right foot.

The diabetes had been adequately controlled but the patient was already exhibiting signs of diabetic complications, such as background retinopathy and neuropathy. On examination, she had a right convex triangular foot, with an ulcer under the head of the fifth metatarsal head following callus formation at this site (Figure 3.15). She had symptomatic diabetic neuropathy, exemplified by a burning sensation in the feet, which was especially exacerbated at night; peripheral pulses were palpable and the ankle brachial index was 1.0 bilaterally. Small muscle atrophy of the feet was noted, as well as dry skin and loss of feeling of a 5.07 monofilament; vibration perception threshold was 30 V.

A plain X-ray showed a convex triangular foot deformity (Figure 3.16). This deformity is characterized by convergence of first and fifth toes, and claw deformities of the central three toes. The first and fifth metatarsals are short and diverge. Both longitudinal and transverse plantar concavities are accentuated, and the second and third metatarsals are fixed in excessive equinus

Figure 3.15 Neuropathic ulcer under fifth metatarsal head

Figure 3.16 Plain radiograph of a convex triangular foot

from this level. Cavus feet balance on the heel and the central part of the metatarsal paddle. This deformity may cause high pressures over the metatarsal paddle during walking.

Debridement was performed and appropriate footwear and insoles were prescribed (Figure 3.17). A suitable insole relieved pressure strain from the sole of the patient's foot by redistributing pressures. High plantar pressures can be seen on the graph produced by insole pressure sensors (Parotec system, Germany) (Figure 3.18), when the patient used her own shoes (Panel A), and after the prescribed insole and shoe were used (Panel B); pressures applied to the sole of the patient's foot during heel strike, midsupport and push-off phase of walking with the patient's original shoe (left graph), and with the custom-made insole (right graph) are shown in Panel C.

After 6 weeks the ulcer heeled completely (Figure 3.19).

Keywords: Convex triangular foot; hallux valgus; quintus varus

HALLUX VALGUS, OVERRIDING TOE, CLAW TOES, EDEMA

A 68-year-old female patient with type 2 diabetes diagnosed at the age of 45 years attended the outpatient diabetic foot clinic

Figure 3.17 Extra-depth shoes and custom insoles

for routine chiropody treatment. She was being treated with insulin. The patient had hypertension, advanced background retinopathy which had been treated with laser in both eyes, and diabetic nephropathy (urine protein: 2.6 g/24 h). On examination, she had severe diabetic neuropathy and gross ankle edema due to nephropathy. Peripheral pulses were normal and the ankle brachial index was 1.1 on both feet. Mild hallux valgus, claw toes, overriding of the second to the third toe and lateral drip of the toes were observed (Figures 3.20 and 3.21). Callus formation at the inner aspect of the first and on the second metatarsal heads was noted. Fat pads on the first, second and third metatarsal heads were displaced distally to the base of the proximal phalanges due to clawing of the toes. A superficial painful infected ulcer at the dorsum of the second toe was also present, due to overriding and clawing of the toes. Debridement of the callus was carried out. The patient was put on clindamycin for 2 weeks. Treatment with frusemide 40 mg daily was also commenced to reduce edema. Extra depth shoes and orthotic insoles were prescribed in order to reduce the pressure on the plantar area and the friction from the shoes on the deformed toes.

The correct shoes and orthotic insoles are often enough to reduce the risk for foot ulceration in the majority of the patients with foot deformities and loss of protective sensation. In addition, edema has a detrimental effect on the foot at risk, as it reduces local blood supply and has been associated with increased risk for ulceration. Therefore, reduction of ankle edema is recommended for patients at risk for ulceration.

Beyond diabetic nephropathy, other causes of ankle edema in diabetes include heart failure and diabetic neuropathy. Edema due to neuropathy is not rare. This form of edema results from sympathetic denervation, which leads to loss of the vasomotor reflex upon standing, arteriovenous shunting and increased capillary pressure. Neuropathic edema responds to the administration of the sympathomimetic agent ephedrine.

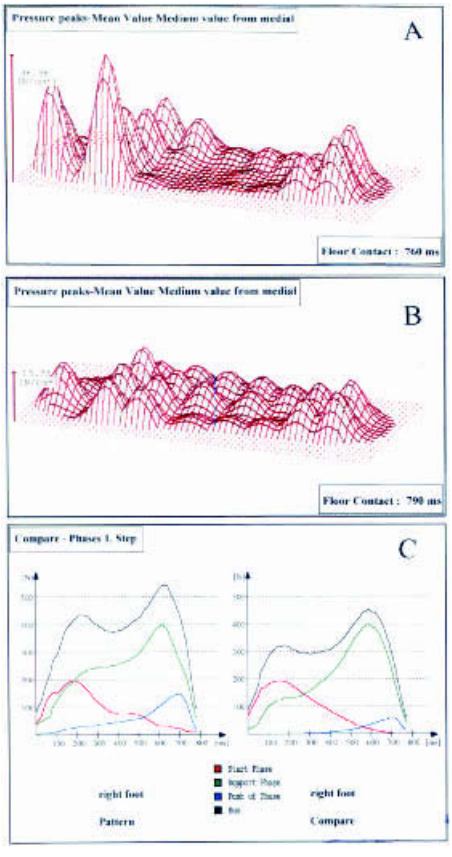

Figure 3.18 In-shoe plantar pressure measurements (A) when the patient used her own shoes; and (B) after wearing the prescribed insole and shoe. (C) Pressures on the sole of the patient's foot during walking in her own shoes (graph on left), and when wearing the custom-made insole (graph on right)

Keywords: Hallux valgus; toe overriding; claw toes; edema

ONYCHOMYCOSIS; HALLUX VALGUS AND HAMMER TOE DEFORMITY

A 68-year-old female patient with diabetes diagnosed at the age of 50 years and

Figure 3.19 The neuropathic ulcer shown in Figure 3.15 after it had healed following 6 weeks of treatment

treated with insulin, was referred to the outpatient diabetic foot clinic because of foot deformities and recurrent superficial toe ulcers.

The patient had findings of peripheral neuropathy. Peripheral pulses were palpable. No other diabetic complications were present.

Onychomycosis was noticed and confirmed by direct microscopic examination of nail specimens. The skin on her feet was dry; hallux valgus and hammer toe deformity of her second left toe were observed. Tiny superficial ulcers on the dorsum of her second and third toes due to shear pressure were present, as well as a small ulcer on the inner aspect of her great toe, and

Figure 3.20 Hallux valgus, overriding toe, claw toes and edema

a hemorrhagic callus on the tip of the left great toe (Figures 3.22 and 3.23).

Mild hallux valgus and hammer toe deformity on the right second and third toes was apparent, with a superficial ulcer on the dorsum of the second toe (Figure 3.24). Hammer toe is a complex deformity consisting of contraction (hyperflexion) of the proximal interphalangeal joint, while the metatarsophalangeal joint is either dorsiflexed or in the neutral position. The distal interphalangeal joint may be in the neutral position, hyperextended or in plantar flexion (Figure 3.25). Hammer toe may be flexible or rigid.

Overriding toe deformity often occurs in the second and the fifth toes. The cause of the overriding fifth toe is mainly congenital, while a second overriding toe is acquired and multifactorial. Elongation and laxity of the plantar synovium bursa of the metatarsal joint result in dorsal subluxation of the affected joint. The second toe lacks plantar interossei muscles, therefore lumbrical muscles predominate, causing dorsiflexion of the toe. Subluxation of the metatarsophalangeal joint results in shrinkage of the dorsal synovium bursa and the dorsal interossei muscles. Further atrophy of the intrinsic muscles contributes to the development of the deformity which may be fixed or flexible.

Debridement of the calluses and instruction in foot care was provided to this patient, and shoes with a high toe box and shock absorbing insoles were prescribed.

Figure 3.21 Hallux valgus, overriding toe, claw toes and edema. Plantar aspect of the foot illustrated in Figure 3.20

Keywords: Onychomycosis; hallux valgus; hammer toe deformity

MALLET TOE

A mallet toe consists of plantar flexion of the distal interphalangeal, and neutral position of metatarsophalangeal and proximal interphalangeal joints (Figure 3.26).

Toe deformities (hammer, claw, curly, mallet toe and overriding of toes) are unknown in non-shoe wearing populations. Their incidence varies from 2 to 20%, and increases with age. Women are affected four to five times more often than men. Most people have no underlying disease, although neuromuscular diseases and inflammatory arthropathies may be accompanied by such toe deformities.

Toe deformities are more common in people with diabetes, due to muscle atrophy and limited joint mobility. Deformities such as those described above, when present in a patient with loss of sensation due to diabetic neuropathy, pose a risk for the development of neuropathic ulcers, as prominences are susceptible to skin-on-shoe friction. Patients are instructed to check their feet every day. Shoes with a high toe box protect the deformed toes from ulceration.

Figure 3.22 Hallux valgus, toe overriding and onychomycosis

Figure 3.24 Mild hallux valgus and hammer toe deformity on the right second and third toes, with a superficial ulcer on the dorsum of the second toe. Right foot of the patient whose feet are shown in Figures 3.22 and 3.23

Figure 3.23 Hammer toe deformity of the second, third and fourth toes, hemorrhagic callus and onychomycosis. Anterolateral view of the foot shown in Figure 3.22

Figure 3.25 Hammer toe

Figure 3.26 Mallet toe

Keywords: Mallet toe; toe deformities

PROMINENT METATARSAL HEADS AND CLAW TOES

A 65-year-old male patient with longstanding type 2 diabetes attended the outpatient diabetic foot clinic for callus removal and treatment of ulcers on the tip of his second and fifth right toes (Figure 3.27).

On examination, he had bounding pedal pulses, and severe peripheral neuropathy. Metatarsal heads were prominent, and claw toes were present.

Claw toe deformities may cause prominence of metatarsal heads with subsequent

Figure 3.27 Prominent metatarsal heads and claw toes

callus formation and ulceration. Ulcers may develop at the tips of the claw toes, since they are abnormally exposed to pressure during walking.

Protective footwear (high toe box and orthotic insoles) was provided to this patient.

Keywords: Claw toes; prominent metatarsal heads

POSTOPERATIVE HALLUX VALGUS AFTER SECOND TOE REMOVAL

A 55-year-old female patient with type 2 diabetes diagnosed at the age of 40 years, treated with insulin, and erratic glycemic control, visited the diabetic foot clinic because of recurrent callus formation. She had background retinopathy, hypertension, and severe peripheral neuropathy, and a history of amputation of her left second toe 3 years previously due to osteomyelitis after a perforated ulcer.

After removal of her second toe, her left great toe gradually dislocated to a valgus posture, underriding the adjacent (third) toe (Figure 3.28). Gross callus formation developed at the medioplantar aspect of the first metatarsal head, which caused constant discomfort during walking and dancing (Figure 3.29). Callus was also noticed over the third metatarsal head.

At the outpatient clinic the callosity was removed and a full thickness ulcer revealed. More callus built up quickly as a result of the very active lifestyle of the patient and her refusal to wear appropriate footwear, she therefore had to attend the clinic every week.

A plain X-ray showed disarticulation of the left second toe, dislocation of the

Figure 3.28 Hallux valgus and toe overriding after second toe disarticulation

Figure 3.29 Gross callus formation on the first and third metatarsal heads after second toe disarticulation

metatarsophalangeal joint of the great toe, medial pronation of the first metatarsal head, and hallux valgus deformity with rotation, together with dislocation of the sesamoids, and arthritis; necrosis of the head of the third metatarsal bone was also evident (Figure 3.30).

She was referred to the orthopedic department where her second metatarsal was removed. The hallux valgus deformity was corrected by arthrodesis of the metatarsophalangeal joint.

After the operation there was no significant callus development within the next 3 months (Figure 3.31).

Keywords: Hallux valgus; prophylactic surgery; second ray amputation

FIRST RAY AMPUTATION

A 72-year-old male patient with type 2 diabetes diagnosed at the age of 56 years and

Figure 3.30 X-ray image of the foot illustrated in Figures 3.28 and 3.29. Disarticulation of the left second toe, dislocation of the metatarsophalangeal joint of the great toe, medial pronation of the first metatarsal head, and hallux valgus deformity with rotation, together with dislocation at the sesamoids and arthritis; necrosis of the head of the third metatarsal bone is also evident

Figure 3.31 Photograph of the foot shown in Figures 3.28–3.30 3 months after arthrodesis of the first metatarsophalangeal joint and second ray amputation. Note the absence of significant callus formation

treated with sulfonylurea and metformin, attended the outpatient diabetic foot clinic because of a deep, infected neuropathic ulcer under the first metatarsal head. His diabetes control was acceptable (HBA_{1c}: 7.6%). He had a history of hypertension and dyslipidemia and was being treated with a combination of angiotensin converting enzyme inhibitor with diuretic and simvastatin. He had neuropathic pain in his feet. He described the pain as a burning sensation which worsened at night. On examination, an ulcer 3 × 3 cm in size and 1.5 cm in depth surrounded by callus formation was seen on the left first metatarsal head. Its base was sloughy. Second left claw toe deformity was also observed. Pedal pulses were palpable, the ankle brachial index was 1.0; the patient had findings of severe peripheral neuropathy (loss of sensation of light touch, pain, temperature, vibration, and 5.07 monofilaments; the vibration perception threshold was 35 V on both feet).

A plain radiograph revealed osteomyelitis of the first metatarsal head extending to the base of the proximal phalanx of the great toe. Cultures of the base of the ulcer revealed the presence of *Staphylococcus aureus* and *Escherichia coli*. Based on the results of the swab culture he was given amoxicillin and clavulanic acid for 2 weeks. After this time a first ray amputation under local anesthesia was carried out. A culture of the bone was negative for pathogens but pathologic examination of the resected bone showed findings of chronic osteomyelitis (granulated fibrous tissue with a predominance of plasma cells and lymphocytes and involucrum formation at the periosteum). The postoperative period was free from complications and the wound healed well in 2 weeks (Figure 3.32). Antibiotics

Figure 3.32 First ray amputation due to osteomyelitis

were discontinued 7 days after the operation and he was put on imipramine for the neuropathic pain.

Removal of the great toe results in dysfunction of the foot during both stance and propulsion. This disability is related to the length of the removed metatarsal shaft. Most surgeons preserve the longest metatarsal shaft possible. The base of the proximal phalanx should be preserved, in order to keep the attachment of the short flexor of hallux intact, thus keeping sesamoids in place and maintaining the windlass mechanism. This mechanism protects the first metatarsal head from overloading during the propulsion phase of gait. In the case of an obligatory removal of hallux — due to osteomyelitis of the proximal phalanx — the surgeon should preserve all uninvolved portions of the metatarsal, except the avascular sesamoids and their fibrocartilaginous plate. A hallux disarticulation at the metatarsophalangeal joint exposes the head of the third metatarsal to abnormally high pressure during stance, and may displace the second toe medially.

Keywords: First ray amputation; histology; chronic osteomyelitis

CALLUS UNDER BONE PROMINENCE

A 72-year-old male patient with type 2 diabetes attended the outpatient diabetes clinic for his usual follow-up. His diabetes control was fair with glibenclamide. He was free

Figure 3.33 Callus over prominence of metatarsal head

from retinopathy or nephropathy, but he had severe diabetic neuropathy. On examination a callus was present under the head of his right third metatarsal, which caused minor discomfort (Figure 3.33). Another bony prominence was evident on the outer aspect of his fifth metatarsal, without callus formation. Claw toes, onychomycosis and dry skin were also present. The callus was removed, and a tiny superficial ulcer revealed. The patient was prescribed extra depth shoes with orthotic insoles (preventive footwear). Hydrating cream was used to prevent skin cracking.

Keywords: Callus; claw toes; dry skin

CALLUS OVER PROMINENT METATARSAL HEADS

A 70-year-old female patient who had type 2 diabetes since the age of 50 years and was being treated with insulin, attended the foot clinic for chiropody treatment. She had a history of ischemic heart disease (myocardial infarction and stroke), peripheral vascular disease treated with low dose

of aspirin; and proliferative retinopathy. She complained of numbness in both feet and a deep aching pain in her calves and painful heel cracks.

On examination, peripheral pulses were absent and her ankle brachial index was 0.8 on the left and 0.7 on the right. The vibration perception threshold was 30 V in both feet. Achilles tendon reflexes were absent, and pain, temperature, light touch and vibration sensation were severely diminished. Pes cavus and hallux valgus were present on both feet (most prominent on the left), together with an obvious prominence of her metatarsal heads and callus formation. The fat pads of her metatarsal heads were translocated towards the toes. The skin on her feet was dry (Figure 3.34). The calluses were debrided on a regular basis, and appropriate footwear was prescribed. Heel cracks (see Figure 4.6) persisted despite debridement.

Calluses develop in areas of high pressure in the feet as a physiological reaction of the skin in response to loading. A callus adds further pressure to the underlying tissues functioning as a foreign body under the foot. Prospective studies have shown that regular removal of calluses reduces the risk of foot ulceration.

Figure 3.34 Callus over prominence on metatarsal heads. Pes cavus and hallux valgus

Keywords: Prominent metatarsal heads; callus

HEMORRHAGIC CALLUS

A 64-year-old male patient with type 2 diabetes diagnosed at the age of 47 years attended the outpatient diabetic foot clinic because of an ulcer under his right foot.

On examination, a painless ulcer surrounded by a hemorrhagic callus was seen under the third metatarsal head (Figure 3.35). Claw toe deformity, a curly

Figure 3.35 A neuropathic ulcer under a hemorrhagic callus

fourth toe, and a heloma molle in the fourth interdigital space were also observed. The patient had bounding peripheral pulses and severe peripheral neuropathy. After sharp debridement of his callus, an ulcer of dimensions 2.0 × 1.5 cm and depth 1 cm was revealed. Plantar fascia was exposed. A plain radiograph excluded osteomyelitis. The patient was instructed in foot care. Offloading of the ulcer area was achieved by the use of an 'almost half' shoe (Figure 3.36) and a total-contact orthotic insole, with a window under the ulcer area. These shoes cause instability, so the patient was instructed to use a crutch. The ulcer healed completely in 8 weeks.

The cause of the ulcer in this patient was high plantar pressure under his prominent metatarsal heads (Figure 3.37). After the ulcer had healed, protective footwear (extra depth shoes and custom-made insoles) was prescribed in order to reduce the peak pressure on the third metatarsal head. No relapse of the ulcer occurred in the subsequent months.

Keywords: Hemorrhagic callus; half shoes; protective footwear

Figure 3.36 Therapeutic half shoe for the treatment of forefoot ulcers

ULCER UNDER A CALLUS AREA

A 70-year-old male patient with longstanding type 2 diabetes attended the outpatient diabetic foot clinic for callus removal on his right foot. On examination, a neuropathic ulcer surrounded by callus was noticed under his fourth metatarsal head (Figure 3.38). He had normal peripheral pulses and severe peripheral neuropathy. Claw toes, varus deformity of the foot and prominent metatarsal heads on his right foot

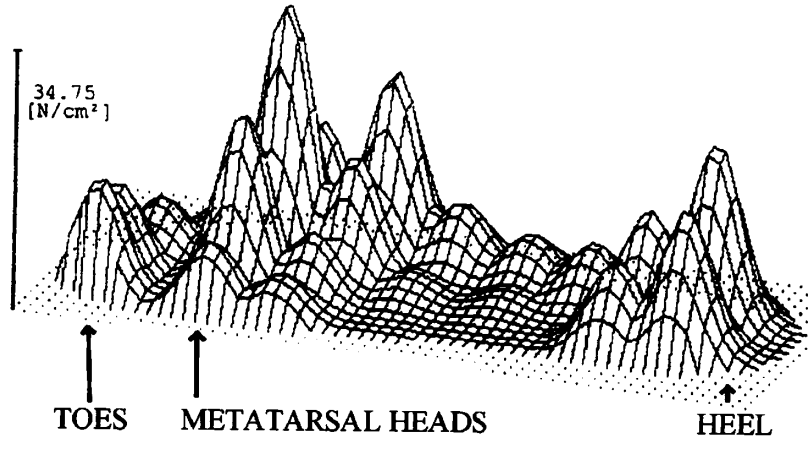

Figure 3.37 Peak plantar pressures recorded with a pedobarograph

were observed. Discoloration of the skin on the lower tibia due to venous insufficiency was also evident. The callus was debrided. Shoes and insoles similar to those shown in Figure 3.36 were prescribed until the ulcer healed. The cause of the ulcer in this patient was the callus resulting from high plantar pressures. High peak pressures are present in almost all cases where there are prominent metatarsal heads due to claw toe deformity. Prevention of callus formation is necessary to avoid recurrence of the ulcer. Protective footwear was prescribed after the ulcer had healed.

Keywords: High plantar pressure; callus, prominent metatarsal heads; varus deformity

Figure 3.38 A neuropathic ulcer under a callus

ULCER UNDER HALLUX

A 70-year-old male patient with longstanding type 2 diabetes treated with insulin and sulfonylurea, attended the outpatient diabetic foot clinic because of a hemorrhagic callus under the phalangophalangeal joint of the right hallux (Figure 3.39). He had ischemic heart disease, hypertension, peripheral vascular disease, background retinopathy and microalbuminuria. The patient had severe diabetic neuropathy; the ankle brachial index was 0.7. After his callus was debrided a clean neuroischemic ulcer was revealed. A plain radiograph excluded osteomyelitis. Therapeutic footwear was prescribed and the ulcer healed in 6 weeks.

The forefoot is the usual site for ulceration. In one series, ulcers of the forefoot accounted for 93% of all foot ulcers. Almost 20% of the ulcers developed under the hallux, 22% over the metatarsal heads, 26% on the tips of the toes and 16% on the dorsum of the toes. Ulcer under the hallux is associated with rigid hallux and high peak pressures on this area.

Keywords: Hemorrhagic callus; prevalence of foot ulceration

HEEL CRACKS

Painful heel cracks due to dry skin were noted in the patient whose feet are shown in Figure 3.34 (Figure 3.40).

Dry skin in diabetic patients is caused by sympathetic cholinergic denervation of the sweat glands in their feet. Patients with dry foot skin often develop reactive hyperhydrosis of the upper body. Heel cracks

Figure 3.39 Hemorrhagic callus under the hallux

Figure 3.40 Heel cracks

may become infected and may lead to deep ulcers with calcaneous involvement if left untreated. The crack resists healing, despite the correct foot care. Heel cracks are aggravated by microvascular disease and neuropathy, and resist healing, despite adequate foot care. Local application of hydrating creams — avoiding the areas between the toes — is the treatment which is usually recommended.

Keywords: Dry skin; heel cracks

BILATERAL CHOPART DISARTICULATION

A 73-year-old male patient with type 2 diabetes diagnosed at the age of 61 years attended the outpatient diabetes foot clinic for a chronic ulcer under his left partially amputated foot. He had had bilateral mid-tarsal (Chopart) disarticulations (on the right foot at the age of 66 years and on the left foot at the age of 68 years) because

of infected foot ulcers under the metatarsal heads complicated by osteomyelitis.

On examination, his feet pulses were palpable, but the patient had severe peripheral neuropathy. A full thickness neuropathic ulcer, which developed 2 months after the amputation, was evident on the plantar area of the left foot (Figure 3.41). The patient had never used any ankle prosthesis or orthosis, but instead used crutches and shoes with a firm outsole and a soft molded insert. The ulcer healed for a period of only 2 months, when the patient was hospitalized because of a hip fracture.

Chopart disarticulation is performed through the talonavicular and calcaneocuboid joints, preserving the hindfoot only (talus and calcaneus). As no muscles attach to the talus, all active dorsiflexion of the remaining short foot is lost. However, dorsiflexion can be restored, by reattaching the anterior tibial tendon to the neck of the talus. Chopart disarticulation preserves the normal length of the leg and the patient can undertake limited walking without a prosthesis. Reasonable walking is possible by the use of an intimately fitting fixed-ankle prosthesis or orthosis placed into a shoe with a rigid rocker bottom.

In the present case, walking without crutches was not possible even if an appropriate prosthesis was used because of the bilateral Chopart disarticulation. However, the use of a prosthesis and offloading the pressure on the ulcerated area with suitable insoles helped to heal the ulcer. In addition, the patient's severe instability, which was the cause of the hip fracture, was reduced.

Any type of amputation alters the biomechanics of the foot and is considered to be a risk factor both for a recurrence of foot ulceration and for a new amputation. Several studies have shown that previous amputations account for 30–50% of new amputations on the same or the contralateral foot within the following 5 years.

Keywords: Neuropathic ulcer; mid-tarsal disarticulation; Chopart disarticulation

NEUROPATHIC ULCER

An ostensibly small neuropathic ulcer surrounded by callus formation was present under the fourth metatarsal head

Figure 3.41 Full thickness neuropathic ulcer in a patient with Chopart disarticulation

Figure 3.42 A neuropathic ulcer under callus formation in a patient with fourth toe disarticulation

(Figure 3.42) of a patient with severe diabetic neuropathy. A history of fourth toe disarticulation at the metatarsophalangeal joint was reported to have occurred 2 years previously because of osteomyelitis in the proximal phalanx. Claw second and third toe, quintus varus (due to fourth toe disarticulation), dry skin and heel cracks were also present. The real size of the ulcer was $1.5 \times 1.5 \times 1.0$ cm post-debridement. The little toe diverged medially and the third toe laterally. Therapeutic footwear was prescribed and the ulcer healed in 2 months.

A fourth ray amputation may lead to better functional and cosmetic results. Sole incisions pose a risk for ulceration; therefore incisions are carried out on the dorsum or the side of the foot. Scar tissue which has healed over an ulcer may predispose to new ulceration in a similar manner to callus formation.

Figure 3.43 Onychocryptosis (ingrown nail) of both halluxes. Note brown nail discoloration probably caused by chronic infection with *Candida albicans*. Second, third, and fourth left claw toe deformity

Keywords: Fourth toe disarticulation; neuropathic ulcer

INGROWN NAILS (ONYCHOCRYPTOSIS)

An ingrown toenail is a common condition usually affecting the hallux. A section of a nail curves into the adjacent flesh and becomes embedded in the soft tissue (Figure 3.43). Peeling the nail at the edge or trimming it down at the corners is the most common cause. In addition to congenital or traumatic reasons, ingrown nails may be caused by tight shoes or socks which press on the sides of the nail making it curve into the skin.

An ingrown nail predisposes to local infection (paronychia) as it provides an entry point for pathogens; therefore it should be treated as soon as it is recognized. Nails should be trimmed in a straight line.

Infection with *Candida albicans* is another cause of chronic paronychia, especially when patients' feet are exposed to moisture for long periods. The nail is usually affected and becomes ridged, deformed and brown.

Keywords: Onychocryptosis; ingrown nail